Digital Elevation Models of West Florida Coast: Procedures, Data Sources, and Analysis

Prepared for the Consumer Option for an Alternative System to Allocate Losses (COASTAL) Act by the NOAA National Centers for Environmental Information (NCEI)
March 31, 2020
Amante, C.J., M.R. Love, M.R. Stiller and K.S. Carignan

Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO
NOAA National Centers for Environmental Information, Boulder, CO

Summary

In March of 2020, NOAA's National Centers for Environmental Information (NCEI) developed integrated bathymetric–topographic digital elevation models (DEMs) according to specifications developed jointly by NOAA NCEI and the United States Geological Survey (USGS) to help better define a consistent elevation mapping framework for the nation (Table 1). Overall, 52 tiled DEMs were created in the area of interest: 41 tiles were created at the highest resolution of 1/9th arc-second and 11 were created at a resolution of 1/3rd arc-second. Only 1/9th arc-second DEM tiles integrate topography and bathymetry. The DEM tiles represent best publicly-available data at the time of their creation; the intent is to update specific tiles as new source data becomes available. The utilization of a tiling scheme in developing the DEMs is intended to improve data management during source data processing as well as facilitate targeted DEM updates.

The tiled DEMs cover the West Florida coast between Apalachee Bay near Tallahassee and Sarasota, which importantly includes the Tampa Bay and St. Petersburg region. The extents of these DEMs, procedures, data sources, and analysis are described below. The methodologies used by NCEI in developing DEMs are described in the NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida (Amante, 2018).

Table 1. Specifications for the DEM tiles.

Grid Area	*West Florida Coast*
Coverage Area	84.00° to 81.75° W, 27.25° to 30.50° N
Coordinate System	Geographic decimal degrees
Horizontal Datum	NAD 83
Vertical Datum	NAVD 88
Vertical Units	Meters
Cell Size	Variable (1/9th or 1/3rd Arc-Second)
Grid Format	Geotiff

DEM Specifications

The West Florida tiled DEMs were built to the specifications listed in Table 1. Figure 1 shows the 1/9th arc-second DEM tile boundaries in orange and the 1/3rd arc-second DEM tile boundaries in green.

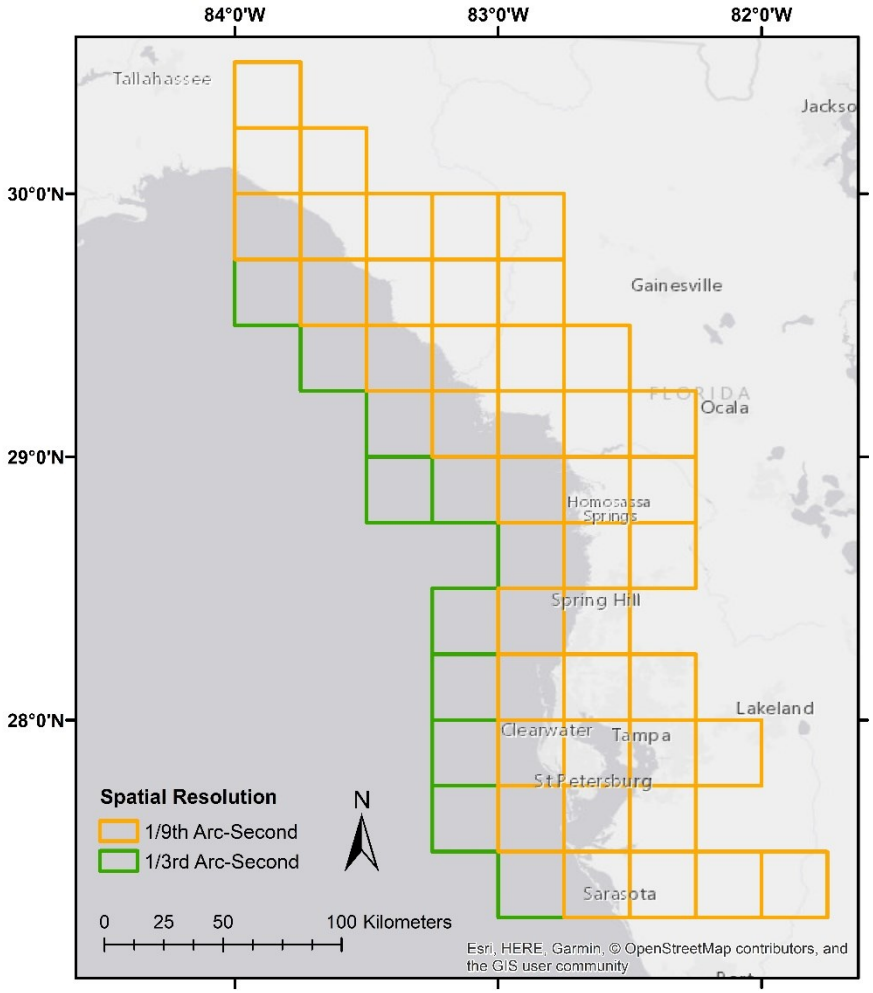

Figure 1. Map image of the DEM tile boundaries for the West Florida Coast DEMs.

Data Sources and Processing

Bathymetry data used in the generation of the West Florida Coast DEMs included NOAA National Ocean Service (NOS) hydrographic surveys and bathymetric attributed grids (BAGs), NOAA Office of Coast Survey (OCS) electronic navigational charts (ENCs), NOAA NCEI multibeam survey data, the U.S. Army Corps of Engineers (USACE) channel condition surveys, and XYZ points from a composite NOAA NCEI coastline

derived from Landsat imagery (Sayre et al., 2018) and the USGS National Hydrographic Dataset (NHD; U.S. Geological Survey (2019)) coastline (Table 2).

Table 2: Bathymetric data sources used in DEM development.

Source	***Date***	***Date Type***	***Spatial Resolution***	***Horizontal Datum***	***Vertical Datum***
NOAA NOS hydrographic surveys	1857 - 2019	XYZ	< 10 meters to several kilometers	NAD83	Mean lower low water (MLLW)
NOAA OCS electronic navigational chart (ENC) extracted soundings	1950 - 2019	XYZ	< 10 meters to several kilometers	WGS84	Mean lower low water (MLLW)
NOAA NCEI multibeam bathymetric surveys	1994 - 2017	XYZ	~1 to 10 meters	NAD83	Assumed instantaneous water level
USACE hydrographic channel condition surveys	2001 - 2020	XYZ	~1 to 10 meters	NAD83	Mean lower low water (MLLW)
NOAA NOS hydrographic surveys: bathymetric attributed grids (BAGs)	2010 - 2019	BAGs	0.5 to 5 meters	NAD83	Mean lower low water (MLLW)
NOAA NCEI Composite Coastline (Landsat and USGS NHD)	2019	XYZ from derived coastline	variable	NAD83	NAVD88 (assumed)

With the exception of the NOAA NCEI multibeam bathymetric surveys and the NOAA NCEI Composite Coastline, bathymetric data were transformed from mean lower low water (MLLW) to NAVD88. Vertical datum transformations were performed using NOAA's VDatum Software. Where more recent, higher resolution data existed, older data were edited or superseded.

Bathymetric-topographic data used in developing the West Florida Coast DEMs included bathymetric-topographic lidar from USACE National Coastal Mapping Program (NCMP) and USACE/Federal Emergency Management Agency (FEMA), and recently developed NOAA NCEI CUDEM products to ensure seamless DEMs along the borders of the study area (Table 3).

Table 3: Bathymetric-Topographic data sources used in DEM development.

Source	*Date*	*Data Type*	*Spatial Resolution*	*Horizontal Datum*	*Vertical Datum*
USACE NCMP Topobathy Lidar: Egmont Key (FL)	2012	Topographic-bathymetric lidar	~1 to 3 meter	NAD83	NAVD88
USACE NCMP Topobathy Lidar: Florida Gulf Coast	2012	Topographic-bathymetric lidar	~1 to 3 meter	NAD83	NAVD88
USACE NCMP Topobathy Lidar: Egmont Key (FL)	2015	Topographic-bathymetric lidar	~1 to 3 meter	NAD83	NAVD88
USACE FEMA Post-Michael Topobathy Lidar: Florida Panhandle	2018	Topographic-bathymetric lidar	~1 to 3 meter	NAD83	NAVD88
NOAA NCEI CUDEM - 1/9 arc-second	2017 - 2019	DEM	1/9 arc-second	NAD83	NAVD88
NOAA NCEI CUDEM - 1/3 arc-second	2017 - 2019	DEM	1/3 arc-second	NAD83	NAVD88

Topographic data used in developing the West Florida Coast DEMs included lidar data from the Southwest Florida Water Management District (SWFWMD), Northwest Florida Water Management District (NWFWMD), Florida Division of Emergency Management (FDEM), and Suwannee River Water Management District (SRWMD), topographic DEMs from USGS, and digitized elevations from NOAA NCEI (Table 4).

Table 4: Topographic data sources used in DEM development.

Source	*Date*	*Data Type*	*Spatial Resolution*	*Horizontal Datum*	*Vertical Datum*
SWFWMD Lidar: Marion County	2003	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Pasco District	2004	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Lake Hancock District	2004	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Citrus County BE	2004	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Pasco County - Classified	2004	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Manatee District	2005	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Little Manatee District	2005	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Polk District	2005	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Peace River South District	2005	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Braden River	2005	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: North District	2006	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Rutland Ranch District	2006	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Upper	2006	Topographic	~1 to 3 meter	NAD83	NAVD88

Myakka District		lidar			
SWFWMD Lidar: Hernando District	2007	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Hillsborough/Little Manatee Districts	2007	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
NWFWMD Lidar: Northern Jefferson County	2007	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
FDEM Lidar: Southwest Florida	2007	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
FDEM Lidar: Levy County	2007	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
FDEM Lidar: Dixie County	2007	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
FDEM Lidar: Taylor County	2007	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
FDEM Lidar: Coastal Jefferson County	2007	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
NWFWMD Lidar: Leon County	2007	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SRWMD Lidar: Mallory Swamp and R.O. Ranch (FL)	2007	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
FDEM Lidar: Coastal Pasco County	2008	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
FDEM Lidar: Middle Suwannee River (FL)	2008	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Peace River South	2009	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
USGS Lidar: Suwannee River Expansion (FL)	2011	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Pasco	2011	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Hillsborough	2011	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SWFWMD Lidar: Lake Manatee	2012	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SRWMD Lidar: Ichetucknee (FL)	2013	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SRWMD Lidar: Bell (FL)	2013	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SRWMD Lidar: Greenville (FL)	2013	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SRWMD Lidar: Mayo (FL)	2013	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SRWMD Lidar: Obrien (FL)	2013	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
SRWMD Lidar: Cooks Hammock (FL)	2014	Topographic lidar	~1 to 3 meter	NAD83	NAVD88
USGS NED	2018	DEM	1/3 arc-second	NAD83	NAVD88
NOAA NCEI Digitized Islands	2020	XYZ from digitized islands	variable	NAD83	NAVD88 (assumed)

DEM Development

Development of the West Florida Coast DEM tiles followed procedures documented in NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida (Amante, 2018). Exceptions being that the bathymetric pre-surface was generated at 1 arc-second due to the coarse resolution of offshore bathymetric data, and gridding weights were modified as shown in Table 5. The bathymetric pre-surface derived from data sources in Tables 2 and 3 was converted to XYZ and was utilized in the final DEM creation. Older, coarse, and/or inaccurate bathymetric surveys from NOAA NOS hydrographic surveys, NOAA NCEI multibeam bathymetric surveys, NOAA OCS electronic navigational chart (ENC) extracted soundings, and XYZ elevations extracted from the NOAA NCEI Composite Coastline were used in the bathymetric pre-surface generation but were not used as source datasets in the final DEM creation with MB-System's 'mbgrid.'

Table 5: Data hierarchy used to assign gridding weights in MB-System's 'mbgrid.'

Dataset	***Relative Gridding Weight***
USACE FEMA Post-Michael Topobathy Lidar: Florida Panhandle	100
USACE hydrographic channel condition surveys	10
NOAA NOS hydrographic surveys: bathymetric attributed grids (BAGs)	10
USACE NCMP Topobathy Lidar: Egmont Key (FL)	10
USACE NCMP Topobathy Lidar: Florida Gulf Coast	10
USACE NCMP Topobathy Lidar: Egmont Key (FL)	10
SWFWMD Lidar: Marion County	1
SWFWMD Lidar: Pasco District	1
SWFWMD Lidar: Lake Hancock District	1
SWFWMD Lidar: Citrus County BE	1
SWFWMD Lidar: Pasco County - Classified	1
SWFWMD Lidar: Manatee District	1
SWFWMD Lidar: Little Manatee District	1
SWFWMD Lidar: Polk District	1
SWFWMD Lidar: Peace River South District	1
SWFWMD Lidar: Braden River	1
SWFWMD Lidar: North District	1
SWFWMD Lidar: Rutland Ranch District	1
SWFWMD Lidar: Upper Myakka District	1
SWFWMD Lidar: Hernando District	1
SWFWMD Lidar: Hillsborough/Little Manatee Districts	1
NWFWMD Lidar: Northern Jefferson County	1
FDEM Lidar: Southwest Florida	1
FDEM Lidar: Levy County	1
FDEM Lidar: Dixie County	1
FDEM Lidar: Taylor County	1
FDEM Lidar: Coastal Jefferson County	1
NWFWMD Lidar: Leon County	1
SRWMD Lidar: Mallory Swamp and R.O. Ranch (FL)	1
FDEM Lidar: Coastal Pasco County	1
FDEM Lidar: Middle Suwannee River (FL)	1
SWFWMD Lidar: Peace River South	1
USGS Lidar: Suwannee River Expansion (FL)	1
SWFWMD Lidar: Pasco	1

SWFWMD Lidar: Hillsborough	1
SWFWMD Lidar: Lake Manatee	1
SRWMD Lidar: Ichetucknee (FL)	1
SRWMD Lidar: Bell (FL)	1
SRWMD Lidar: Greenville (FL)	1
SRWMD Lidar: Mayo (FL)	1
SRWMD Lidar: Obrien (FL)	1
SRWMD Lidar: Cooks Hammock (FL)	1
NOAA NCEI Digitized Islands	1
Bathymetric pre-surface	0.00001
USGS NED	0.000001
NOAA NCEI CUDEM (1/9 arc-second)	0.000001
NOAA NCEI CUDEM (1/3 arc-second)	0.000001

DEM Analysis

Once the West Florida Coast DEMs were generated, the DEMs were compared to the high-resolution source elevation data and high-resolution imagery. Inconsistencies were evaluated and resolved based on the most reliable data available. The largest outstanding issues with the DEM tiles are the lack of publicly-available lidar datasets for coastal areas north of Homosassa Springs, inland areas north and south of Perry, FL, and inland areas surrounding Bronson, FL. In such areas, older, coarser-resolution, topographic data were used from the USGS NED DEMs and were manually digitized along the coastline where no USGS NED DEMs existed. When higher-resolution, publicly available data becomes available for these areas, these DEM tiles will be updated with more accurate, detailed elevation information.

References

C.J. Amante (2018) NOAA National Centers for Environmental Information Topo-Bathymetric Digital Elevation Models: East Florida, NOAA, pp. 6.
https://www.ngdc.noaa.gov/mgg/dat/dems/tiled_tr/east_florida_tiled_navd88_2018.pdf

Roger Sayre, Suzanne Noble, Sharon Hamann, Rebecca Smith, Dawn Wright, Sean Breyer, Kevin Butler, Keith Van Graafeiland, Charlie Frye, Deniz Karagulle, Dabney Hopkins, Drew Stephens, Kevin Kelly, Zeenatul Basher, Devon Burton, Jill Cress, Karina Atkins, D. Paco Van Sistine, Beverly Friesen, Rebecca Allee, Tom Allen, Peter Aniello, Irawan Asaad, Mark John Costello, Kathy Goodin, Peter Harris, Maria Kavanaugh, Helen Lillis, Eleonora Manca, Frank Muller-Karger, Bjorn Nyberg, Rost Parsons, Justin Saarinen, Jac Steiner & Adam Reed (2018): A new 30 meter resolution global shoreline vector and associated global islands database for the development of standardized ecological coastal units, Journal of Operational Oceanography, DOI: 10.1080/1755876X.2018.1529714

U.S. Geological Survey (2019) National Hydrography Dataset (ver. USGS National Hydrography Dataset Best Resolution (NHD) for Hydrologic Unit (HU) 4 - 2001 (published 20191002)), accessed December 2, 2019: https://www.usgs.gov/core-science-systems/ngp/national-hydrography/access-national-hydrography-products